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SPECIFICATION WRITING FOR COMMUNICATIONS EQUIPMENT: A COMPARATIVE STUDY OF MILITARY AND CIVILIAN PROCEDURES

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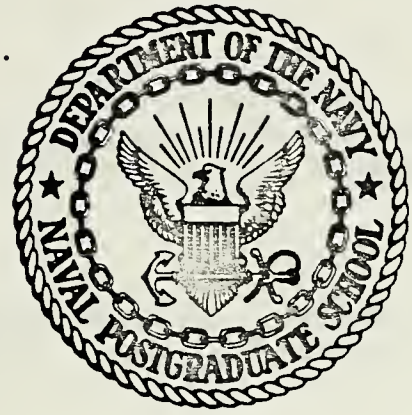

THESIS

Specification Writing for Communications Equipment:
A Comparative Study of Military
and Civilian Procedures

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ABSTRACT

The military often pays more for communication equipment of similar capabilities to that purchased by civilians. Despite this, equipment reliability has proven to be much lower. This study undertook to analyze and compare the salient features of two types of specifications used to express communications equipment requirements by the Navy and commercial airlines. The manner in which requirements are developed and specifications drawn were examined. Procurement procedures, another factor contributing to the price differential, were also examined briefly. Airline specifications, called ARINC Characteristics, and airline procurement methods were shown to encourage competition to a greater degree with a lower price and greater reliability resulting.

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I. INTRODUCTION

In a time when close congressional scrutiny of defense budgets dictates that only essential equipment is bought, it is becoming ever more necessary to find means of obtaining the best value for the defense dollar. Within the memory of most of the people in the armed services today, this recent trend is a radical departure from the World War II and later days when the words, "Essential for national security," attached to any project, brought virtually endless streams of money. It is, perhaps, this attitude, engendered in the "old days," that has brought on the criticism of military spending and has made it so difficult to streamline procurement procedures.

Cost overruns and the consistently higher prices paid by the military are the subject of a succession of congressional speeches and almost daily newspaper articles (at least, prior to Watergate). This study began as an attempt to look into one small area where the military pays a higher price--communications equipment procurement-- and to analyze, if possible, the differences between military and civilian procurement procedures that have led to this condition. This was quickly recognized as a "Pandora's Box" and a subject incapable of being treated fully in one study. The charge of "gold-plating" equipment, often levied in the aforementioned speeches and articles, led to concentration on specifications. Department of Defense (DOD) policy concerning

specifications is simple and straightforward:

> "Plans, drawings, specifications, or purchase descriptions for procurements shall state only the actual minimum needs of the Government and describe supplies and services in a manner which will encourage maximum competition and eliminate, insofar as possible, any restrictive features which might limit acceptable offers to one supplier's product.."[1]

Compliance with this policy should result in the best possible equipment meeting the needs at the lowest cost. If this is the case, charges of "gold-plating" are false and one needs to look elsewhere for the causes behind higher costs to the military. Obviously, other factors have contributed to the higher costs and, to the extent possible in a limited study, these were considered. The main thrust, however, was directed at comparing civilian and military specifications to identify those features which add to the cost.

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[1] Department of Defense, Armed Services Procurement Regulations, 16 April 1973, p. 1-215.

II. METHODOLOGY

To begin a comparison of specifications, one must have some basic background in the manner of determining requirements. To this end, enquiries were made to various commercial users of communications equipment and, within the Navy, to the office of the Chief of Naval Operations (OPNAV) and Commander Naval Telecommunications Command. Since developing and validating a telecommunications requirement is integral to drawing up the equipment specification, a major section of this study was devoted to requirements. With this background, representative specifications for equipments to meet similar requirements were studied. Rather early, it was determined that the field was still too broad to cover adequately. Since the best information available from commercial sources concerned airlines communications equipment and since the closest parallels were in aircraft communications requirements, the study evolved into an analysis of Navy and airline aircraft communications equipment specifications. Using two similar equipment specifications (VHF transceivers) written by the Naval Air Systems Command (NAVAIR) and the Airlines Electronic Engineering Committee (AEEC) as a base, a breakdown of the salient features of the two types of specifications and a comparison of these features were included. After reaching tentative conclusions, the opinions and some factual data were solicitated from several aircraft communications equipment manufacturers. Finally, the writings and

speeches of several senior naval officers (and, in one case, an interview) were studied to provide an outlook on the future and to solidify the author's conclusions on the direction to be taken.

III. REQUIREMENTS

While the requirements themselves often turn out to be quite similar, the manner of determining and validating requirements in the Navy and in civilian airlines differs considerably.

A. CIVILIAN REQUIREMENTS

Airline communications requirements were not always generated with the relative ease and polish apparent today.

1. ARINC Background

Under government prodding, the commercial airlines formed a wholly-owned company, Aeronautical Radio, Inc. (ARINC), in the late 1920's. The initial charter for this company called for it to coordinate requirements and allocate frequencies to the airlines. Each airline continued to procure its own, perhaps unique, equipment and operate an independent ground communications network. The advantages of having a single ground network to handle communications for all airlines became quickly apparent and ARINC was the logical candidate for operating this. The government reentered the picture in the mid-1930's, when a regulatory body within the Department of Commerce (which later successively became the CAA, CAB, and FAA) began issuing compulsory communications equipment specifications for civil aviation in addition to regulating its usage. This prompted the airlines to consider joint requirements, specifications, and purchase of communications equipment. Again, ARINC was chosen as the agent for this task. Eventually, the Airlines Electronic Engineering

Committee (AEEC) evolved to handle the joint requirements and equipment specifications for the airlines. The evolution of this committee and its working concept were not without growing pains. Having the committee speak for the entire airline industry, rather than only those airlines represented, set a precedent. A number of years went by before it was realized that combined purchases from a single manufacturer left the industry with but one source and no competition. Several more years passed before the advantages of manufacturer participation in the specification writing process became apparent. Nevertheless, the AEEC today is a viable, respected body which speaks with authority for the industry on a world-wide basis.[2]

2. Generation of Requirements

Within the airlines, requirements for new equipment can come from several sources. Government regulation, through the FAA or the FCC, can establish requirements. General avionics equipment, a navigation receiver for example, might be requested by flight operations personnel, the ultimate users. Conventions of the International Civil Aviation Organization (ICAO) may indicate still other requirements. The majority of communications requirements, however, are generated within the communications engineering section of an airline. Informal liaison

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[2]Information for this section was derived from AEEC, From Government Dictum to Present Day ARINC Specs, May 1969, and from an interview with R. E. Johnson, Director of Communications Engineering, United Airlines, 14 February 1974.

with other airlines determines the extent of airline interest and whether an industry-wide standard is desirable. The AEEC formalizes the process (without requiring firm commitments from the airlines) and establishes a subcommittee to draw up the specifications. Despite the large and varied representation on the committee, agreement is reached early on the basic requirement and continually as the requirement and specification are refined. Throughout the process, the equipment manufacturers and the users (i.e., the airline pilots) contribute their expertise to the solution.[3]

B. NAVY REQUIREMENTS

Program sponsors (e.g., NAVAIR) and fleet commanders are the two principal sources of communications equipment requirements within the Navy. All such requirements, from any source, are submitted to the Chief of Naval Operations (CNO) for review, validation, and approval.[4] Within the office of the Director of Naval Telecommunications (OP 941), requirements are looked at critically. The concept is questioned. Existing systems are studied to see if the requirement can be handled with present assets. All aspects of the problem are examined and the burden of proof rests with the requestor. Assuming that the requirement passes this test, it is assigned a priority based on category (operational, administrative,

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[3] Ibid.

[4] OPNAV Instruction 11120.5 of 9 March 1967.

etc.) and urgency (cannot operate without, degraded operational capability, etc.).[5] Priorities are reviewed at least annually and requirements satisfied as the budget permits. When priority and budget permit, OP 941 and the cognizant branch within the office of CNO (e.g., the Ship Acquisition Branch) determine whether the requirement can be satisfied by off-the-shelf equipment, either through procurement or from existing Navy stocks. If this is not possible, the requirement is reviewed by OP 941 to determine if it is urgent enough to justify expenditure of research and development (R & D) funds and production costs for new equipment. Passing this hurdle, the requirement must have R & D funds identified and a Specific Operational Requirement (SOR) issued by the Ship Acquisition Branch (OP 97). With these tools, the sponsoring office within the Naval Material Command draws up the initial R & D specifications and lets a contract. Concurrently, production funding for some future year is figured into the budget. While the entire process is iterative and time consuming, the fact that new communications equipment is being procured would indicate that it is not entirely disruptive. A presumed benefit is that invalid requirements are identified and rejected. A failing is that the end user, a flyer who will actually operate the equipment for example, is rarely involved anywhere in the process.

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[5] ACNO (Communications) Instruction 2300.1 of 11 March 1969.

IV. SPECIFICATIONS

The heart of any procurement action is the specification. It is the guideline for the manufacturer on just exactly what product or service is desired and the criteria against which the buyer can measure fulfillment of the contract terms. All specifications have these aims in common. Beyond this, however, military and civilian specifications may differ in many regards. For example, the specifications issued by the AEEC, called ARINC Characteristics, do not commit any airline to purchase equipment built to that specification. The foreward of every ARINC Characteristic states that it has a two-fold purpose:

> "(1) To indicate to prospective manufacturers of airline electronic equipment the considered opinion of airline technical people, coordinated on an industry basis, concerning requisites of new equipment, and
>
> (2) To channel new equipment designs in a direction which can result in the maximum possible standardization of those physical and electrical characteristics which affect interchangeability of equipment without seriously hampering engineering initiative."[6]

The military specification, on the other hand, is issued with the Invitation for Bids (IFB) or Request for Proposal (RFP) requiring a fairly rapid response from industry (usually 30 to 60 days).

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[6] AEEC, ARINC Characteristic 566A, Mark 3 VHF Communications Transceiver, 23 August 1972, p. ii.

Specifications fall into two main categories. A design specification spells out to the manufacturer how an item is to be fabricated, the materials to be used, and their size and shape. It completely defines the item to the extent that a competent manufacturer is capable of building it. By issuing this type of specification, the buyer takes on the responsibility for the performance of the item when manufactured to his specification. A performance specification expresses the buyer's requirements in terms of functional standards such as capacity or outputs. The details of design, fabrication, and internal composition are left to the manufacturer. Rarely is a specification in either a purely design or performance form. A "design" specification, then, merely indicates that the design category predominates.

A. ARINC CHARACTERISTICS

Basic standards and practices are established for the airlines by the ICAO and government regulatory bodies such as the FAA or FCC. These standards provide guidance to both the AEEC in writing the specification and to the manufacturer in complying with it.

1. Format

ARINC Characteristics are performance specifications designed to minimize ambiguities. To this purpose, a narrative style is used in the basic specification to describe the needs. Attachments to the basic document may contain tables or charts when such add to the clarity of the specification. Notes throughout the specification provide background or other explanations as necessary to answer any

anticipated questions. The result is a document intelligible not only to the technical people, but to the managers as well. A notable absence is the reference to specific tests, reliability standards, or preservation and packaging.

2. Features

A primary concern of the airlines in purchasing new equipment is the ability to interchange it with equipment produced by other manufacturers and to place it in any aircraft in their inventory. A large section of the ARINC Characteristic, therefore, is devoted to standardization to effect this interchangeability.

a. Standardization

The standards to achieve interchangeability are common to all ARINC specifications for a particular type of equipment. They include six basic categories:

(1) Form Factor. The specific case, including dimensions, clearances, projections, handles, cooling, weight limits, and center of gravity, is defined. This permits installation into an existing standard rack with little or no reworking of the aircraft.

(2) Connectors and Identification Indexing. Connector type and location is also specified for the particular case to be used. Identification indexing (connector index pins) prevents inadvertently plugging the case into the wrong rack.

(3) Interwiring. Specifying wire to pin in the connector permits independent design of the equipment and the airframe and ensures proper inputs and outputs at the pins.

(4) Power Circuitry. ARINC Specification 413 adapts the military specification, MIL-STD-704, Electric Power, Aircraft Characteristics and Utilization of, to airline requirements. Such subjects as power system characteristics, voltage transients, circuit protection, and emergency power requirements are covered in detail.[7]

(5) Weight. The probable maximum and minimum weights for the unit are set forth. While these are not binding, they permit the installation designer to select common interchangeable shock mounts. The manufacturer is requested to inform ARINC if his equipment weight varies widely from the standards given.

(6) Environmental Conditions. ARINC Report No. 414, General Guidance for Equipment and Installation Designers, provides guidance to the manufacturers on the conditions under which the equipment will be operated. For test purposes, the specification categorizes the equipment into several environmental conditions (e.g., range of temperature, altitude, vibration, etc.) under which it should operate satisfactorily. The airline environmental requirements are similar in most regards to those of MIL-E-5400, Electronic Equipment, Aircraft, General Specification for.

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[7] ARINC Research Corporation Report, A Comparative Analysis of P-3C Avionic Specifications and Similar Commercial Avionic Specifications, by W. D. Gahres, p. 7, March 1973.

b. Performance

While the "black box" itself is specified in great detail in the interest of interchangeability, the contents are not precisely defined. Rather, the functions which the equipment is to perform, operating parameters, and input and output signals are described.[8] These performance standards are agreed upon by the AEEC after consultation with the equipment manufacturers so that all are aware of what is desired and what is attainable. While these standards are the agreed airline position, an individual airline could establish a different standard (either higher or lower) for its own equipment purchases.

c. Problem Background

Long standing or highly complex problems are explained in great detail at the beginning of the applicable section. For example, the airlines began looking at data link communications as early as 1947. Many ARINC Characteristics issued after that time contained provisions to make the equipment compatible with data link operation. When a new specification for a VHF communications transceiver was issued in August of 1972, data link communications were still not in being, however, provisions for that capability were still included.[9] With several paragraphs devoted to the background of the problem, prospective manufacturers

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[8]The pins on which these signals enter and leave are specified.

[9]AEEC, ARINC Characteristic 566A, pp. 15-19.

are made aware of the complexity of the problem as well as solution development to date and probable future trends. A manufacturer just entering the field, then, is quickly brought up to date.

d. Commentary

Ambiguous points in the specifications are explained by one or more commentary paragraphs. In a commentary paragraph entitled, "Why Not Specify A Particular Weight?", it is pointed out that manufacturers are aware of the need for weight reduction and the competitive advantage of a lightweight unit which does not sacrifice performance or strength.[10] The manufacturers can understand the factors underlying the statement of a probable weight range and are not unduly restricted in the design of their equipment.

e. Reliability and Test Standards

Other than a tabulation of the service conditions under which the equipment can be expected to operate, ARINC Characteristics make no mention of standards for testing or of the reliability desired in the equipment. With several manufacturers in competition, each can be relied upon to design the highest practicable mean-time-between-failures (MTBF) into his equipment. This is further encouraged by the airline practice of buying equipment under warranty.[11] "Corporate memory" also

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[10] AEEC, ARINC Characteristic 566, Airborne VHF Communications Transceiver and Mark 1 VHF SATCOM System, 17 October 1968, p. 5.

[11] ARINC Research Corporation Report, The Use of Warranties for Defense Avionics Procurement, by H. Balaban and B. Retterer, p. 9, June 1973.

plays a part. Manufacturers are fully alert to the fact that consistently bad performance will gain them a bad reputation throughout the industry which will affect future business. For these same reasons, the assumption is made that the standards contained in the specification have been met. Each airline establishes its own test standards to check the validity of this assumption based on its own requirements and the past performance of the contractor in question. Such evaluation is slanted more toward ease of maintenance of the equipment than towards its performance characteristics.[12]

B. MILITARY SPECIFICATIONS

As noted earlier, the Department of Defense policy is that specifications should state only minimum needs and should attempt to maximize competition among vendors. With over 68,000 documents, many of them conflicting, impacting on various phases of the acquisition process, this policy is not always easy to implement.[13]

1. Types of Government Specifications

Several types of specifications affect procurement within the military. With few exceptions, use of these standards is mandatory

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[12] R. E. Johnson interview.

[13] National Security Industrial Association, Engineering Advisory Committee, Recommendations for Development of Major Defense Systems DODD 5000.X and Solutions to Design Complexity and Cost Problems, Section i, October 1973.

in securing materials and services covered by the standards.

a. Federal Specifications

The General Services Administration prepares and issues Federal Specifications. These cover items of general application to two or more government agencies (e.g., desks or light fixtures). Included within this category are Federal Standards which establish engineering and technical norms for materials, processes, designs, and engineering practices.

b. Military Specifications

Materials, products, and services used only or predominately by military activities are covered by Military Specifications (MILSPECS) and several subcategories. The MILSPECS are issued by the Office of Standardization in the Defense Supply Agency. Military Standards serve the same purpose within the Department of Defense as Federal Standards do for the government in general. Interim Federal Specifications are prepared and issued by a single military agency for procurements not adequately covered by existing specifications. They are intended for final processing as either new or revised Federal Specification. Limited Coordinated Military Specifications are prepared by a single military department for items in which it alone has an interest (e.g., Army tanks). Any of these may be coordinated among the military departments depending on the commonality of need.[14] Many other

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[14]For example, a specification with the suffix "ASG" has been issued by the Aeronautical Standards Group and is under joint Navy and Air Force cognizance.

subcategories of the Military Specification exist, but most do not apply to avionic equipment and, for the purpose of this study, are ignored.

2. Format

Military Specifications tend to be design oriented and may be divided into four major parts: scope, component classification, references, and detailed requirements. While the scope paragraph provides a brief description of what is required, most of the specification is written in terse language with heavy reliance made on tables, charts, and drawings for clarity. The component classification paragraph indicates what items are to go into the final product, their designation, and refers the reader to applicable paragraphs within the specification. Referenced specifications and standards form a part of the MILSPEC to the extent noted in the detailed requirements. The requirements themselves may range from performance parameters to specifying a particular part by manufacturer and part number.[15]

3. Features

A degree of standardization is desireable in military equipment as well as airline equipment. The reasoning and, consequently, the manner of achieving standardization differ.

a. References

By requiring use of existing Federal and Military Specifications and Standards, uniform performance and quality assurance

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[15] In compliance with regulations, this is usually followed by the phrase, "or approved equivalent."

norms are to be expected. In drawing up the specification, the writer does not have to "reinvent the wheel." Previously established standards provide the manufacturer with the information necessary to select suitable components and assembly procedures.

A manufacturer new to government contracting may be at a disadvantage however. The Commission on Government Procurement traced through the first three levels of references in the federal specifications for the light bulb. They found a total of 313 documents referenced.[16] Acquiring and maintaining a current file of reference specifications can be a costly and difficult task for the manufacturer who is new to the field or who does infrequent business with the government.

b. Standardization of Equipment Type

Each equipment specification delineates the form, fit, and interfacing for its particular application. While the application may include more than one type of aircraft,for example, no attempt is normally made to give it general application to all aircraft. This may explain why the Navy alone has 34 different UHF equipments, seemingly to satisfy the same basic requirement, but none of them interchangeable and several not interoperable.[17] The Air Force apparently has had an even greater

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[16] U. S. Commission on Government Procurement, Report of the Commission on Government Procurement, v. 3, Part D, p. 20, 31 December 1972.

[17] RADM Jon L. Boyes, Director of Naval Telecommunications, in an address to NPGS Communications Management students, 7 February 1974.

problem in this regard. By specifying particular connectors, interwiring problems may be alleviated somewhat.

c. Quality Assurance

Detailed testing requirements are included in the specification to assure quality control. In addition to test requirements contained in a variety of MILSPECs concerning equipment test standards, each specification may contain any special tests which the writer deems necessary. Tests are broken down into four categories:

(1) Preproduction Tests. Prior to equipment production, the contractor must demonstrate that his equipment will meet the standards set forth in the specification. The equipment is then further tested by the government for service approval.

(2) Production Sample Tests. An early sample of the production model is selected for testing to insure that it is equivalent in all respects to the previously approved preproduction sample.

(3) Acceptance Tests. This category is further broken down. Individual tests must be passed by each equipment submitted for acceptance. In addition, a regular schedule for selecting equipments for sampling tests is provided. These more extensive tests are designed to uncover operational problem areas which can be corrected prior to contract completion. Reliability assurance tests expose the equipment to the complete range of environmental conditions contained in the specifications. Changes incorporated in the equipment as a result of earlier testing subject a quantity of equipment to special tests to note the effects of the changes.

(4) Life Tests. A specified quantity of equipments are subjected to a series of operational tests of long duration to identify high failure rate items. In this test, failed parts are replaced as necessary and the test resumed.

Test procedures, with the exception of the service approval test which is conducted by the government, are prepared by the contractor and approved by the procuring activity. All of the tests have heavy documentation requirements.

d. Performance Objectives

The MILSPEC seeks improvement over the minimum standards contained in it. When the characteristics of specified parts are such that they will not best fulfill the requirements, the manufacturer is directed to recommend changes. He is further encouraged to improve on any performance standard where possible without adding to the cost. Any recommended changes or improvements must be fully documented and approved prior to implementation.

V. COMPARATIVE ANALYSIS OF SPECIFICATIONS

To begin a comparative analysis of military and civilian specifications and their underlying considerations, it is useful to be aware of some of the facts and to make some assumptions about each of the two procedures.

A. FACTS AND ASSUMPTIONS

It is safe to assume that the goal of both the military and commercial airlines is the best possible equipment at the lowest cost. A high degree of reliability is a related goal. One study indicated that the reliability achieved by the airlines was, on the average, at least twice that attained by the Air Force for similar equipment operated in identical operational environments. One reason for this, the author concluded, was the maintenance procedures and the experience of maintenance personnel.[18] Ease of maintenance, then, is assumed to be important to both. Equipment down time means loss of profits to commercial airlines and a lower state of operational readiness to the military. The high turnover rate of maintenance personnel in the military as compared with the airlines contributes to the military's problem in this regard.

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[18] P. J. Klass, "New Data Yield Clues to Reliability," Aviation Week & Space Technology, v. 86, pp. 80-87, 13 February 1967.

With some combat exceptions, aircraft belonging to airlines and the military operate in identical land and atmospheric environments.

B. USER PARTICIPATION

Sound management practice dictates the user should become involved in the development of an equipment or system. Any large, well-managed organization developing an Automated Data Processing (ADP) system, for example, would not consider imposing this system on the user without involving him in the analysis, design, selection, and implementation processes. To do so would virtually assure failure of the system. The airlines, in general, well-managed organizations, involve the user at every stage. While the idea of a requirement may originate in the communications engineering section of an airline, it is discussed with the pilots who will operate the equipment before the requirement is finalized. When brought before the AEEC, more users are consulted to determine where compromises need and can be made. After the equipment is built to a specification and before a selection is made, the men who are to be charged with maintaining it are consulted. Their recommendatiosn carry considerable weight in the selection process. In the military, it is rare to see the ultimate user involved in developing a requirement or selecting an equipment for purchase. The requirement is normally generated at a high-level staff (e.g., Fleet Commander) after, at most, cursory discussion with users. While these staff "experts" have a good background in operational requirements, they have usually been away from the operational environment for a number of years. The

tendency, then, is to look at the "big picture" at the expense of some forgotten details. The maintenance man on the line, if he is lucky, will receive some training on the equipment before it is delivered. More often, he first sees the inside of the "black box" when it breaks down.

C. MANUFACTURER PARTICIPATION

When a requirement is brought before the AEEC, manufacturers are invited to participate in the validation and specification writing. While they have no vote in the committee, they contribute invaluable expertise on the state of the art and the probable cost of adding the last couple of decibels to the specification. The frank discussions in the committee acquaint the airlines with what can be bought for the price they want to pay and eliminates the costly "nice to have" accessories. The manufacturers profit as well by gaining a better understanding of just what is required by the airlines. Manufacturer involvement in the military procurement process generally begins when a request for proposal (RFP) or an invitation for bids (IFB) is issued. Contact at an earlier stage is officially discouraged as this can lead to restricting the specifications to fit one manufacturer's product. Firm specifications are included with the IFB when issued. It is at this stage that feedback from the manufacturers is invited. Ambiguous points or inconsistencies raised by one prospective bidder must be clarified for all, resulting in possible delays. No utilization is made of industry know-how in technical, production, or management areas.

D. PERFORMANCE VS DESIGN

ARINC Characteristics state detailed requirements for the form and fit of the final product. Beyond that, the specification stresses functional requirements, giving the manufacturer the leeway needed to design a competitive product. The airlines, in other words, are more concerned with the job accomplished than with what is inside the equipment. In constrast, MILSPECs provide less information concerning form, fit, and interfaces, but cover internal elements and subsystems in minute detail. Specific components, by manufacturer and part number, are often included. While the words "or approved equivalent" and a performance standard are normally appended, the effect is to exclude other components. In a study conducted for the Navy by the ARINC Research Corporation, it was noted that an inertial navigation equipment specification, by explicitly stating the required components of the control gyro assembly, insured that only one manufacturer could meet that specification, since only that manufacturer could have the detailed information necessary for assembly of the components.[19]

E. STANDARDIZATION

The overriding consideration of interchangeability required by the airlines has led to the inclusion of very specific standards in ARINC Characteristics. While the state of the art or a desire for additional

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[19] ARINC Research Corporation, A Comparative Analysis..., pp. 12-13.

capability may result in change to performance parameters, the standardization characteristics change little over long periods of time. A manufacturer can develop equipment at any time with some assurance of a market. An additional benefit accrues from the fact that airframe designers can develop new aircraft without regard to the specific brand of avionic equipment to be installed for the airlines. Military specifications, as noted earlier, stress applications which results in a proliferation of equipment designed to do the same job. There is apparently no central clearing-house with the time or the talent to thoroughly analyze requirements for purposes of standardization, though some efforts are being made in this area at the present time. In the procurement arena, a variation of the Golden Rule applies--he who has the gold, rules. Dr. John Foster, in an address to the Armed Forces Communication and Electronics Association in October 1972, noted that there are at least ten different military airborne UHF transceivers of the same vintage, many of which were built by the same manufacturer for different sponsors. Nor is it unusual to find several scientists in one laboratory independently working on the same basic requirements under separate contracts for different sponsors.[20] Some fairly isolated attempts to correct this situation have been made. The inertial navigation equipment specification,

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[20]Interview with RADM W. Cone, USN, Deputy Director, J-6, Joint Chiefs of Staff, 21 February 1974.

cited by the ARINC study done for the Navy, has many standard interfaces incorporated. More general applications for this equipment will undoubtedly result.

F. ENVIRONMENT

While the environmental conditions and categories in ARINC Report No. 414 and MIL-E-5400 are similar in most regards, several manufacturers have cited this as an area where additional costs to the military are incurred. In a desire for reliability under the most severe conditions, many specification writers set unrealistic standards to be met. Carried to the extreme, some equipments are expected to function under conditions in which the aircraft platform cannot operate (e.g., crashed!). While equipment, such as flight recorders, might have these extreme requirements, most avionic equipment do not.

G. WEIGHT

Flexibility in weight requirements can result in substantial savings. Allowing a ten percent increase in weight, for example, might result in a product available for one-half the cost. The ARINC Characteristic takes this into consideration when allowing manufacturers latitude in their designs. MILSPECs, until the introduction of the "design to cost" concept, were rigid in this regard. Exceeding the maximum weight for a unit could be done only at the expense of the contractor's profit.

H. CLARITY

Specifications, at best, are not light reading. To be understood by the engineers who must translate them into a workable product, they must contain the technical language necessary to precisely define the requirements. To rely entirely on technical language however, can obscure the requirements as much as the complete lack of these parameters. Use of a narrative style (with emotional words, if necessary) enables the writer of an ARINC Characteristic to convey the intended meaning of the airlines in setting down their requirements. Background and commentary further serve to remove any ambiguities which might exist. Setting these off from the text by highlighting enables the reader to study the specification in whatever manner suits him (e.g., reading background and commentary first, then considering the technical parameters), contributing to his own understanding of the problem. The sterile language of a MILSPEC conveys nothing to the reader's understanding of the background behind the need and may even conceal the customer's objectives altogether.

I. INNOVATION

An axiom of the free enterprise system is that the producer with the best product at the lowest price will be rewarded with sales. In the military market, this does not always follow. The successful bidder for the military contract is the one who can meet the specifications at the lowest price. Innovative changes that could result in a better product cost him money to develop and raise the price accordingly. In some cases, particularly under an IFB, an innovative response to

government requirements may cause the bidder to be disqualified. While improving on the specification is a goal, the low, responsive bid is an absolute in most cases. Few manufacturers will risk capital in improvements when just meeting the specification promises a greater chance of being awarded the contract. Conversely, the atmosphere of the airline market and performance specifications encourage the manufacturer to gain a competitive edge by incorporating as much new technology into his equipment as possible while remaining within the price range of the market.

J. TESTS

An adversary situation similar to court trials in criminal cases, appears to exist in military procurement. Seemingly endless testing and documentation is required in order for the contractor to prove that his equipment performs to the standards specified. While the airlines conduct varied degrees of testing prior to purchase, they have a simple remedy when the equipment does not work as specified. They no longer buy from the manufacturer.

K. PACKAGING

Preservation and packaging of electronic equipment is the subject of separate MILSPECs. While various levels of preparation for shipment are provided and these are to be addressed in the contract rather than in the equipment specification itself, the distinction is not often made between equipment destined for immediate installation at a nearby activity

and that to be shipped long distances for long term storage. Rather, the highest level of preservation and packaging required by any of the equipment is usually applied to all of the units. In airline purchasing, preservation and packaging is also a function of the contract, however, the purchasing agent, through better acquaintance with the ultimate ends, is able to adjust the preparation for delivery to suit the airline's needs at a cost savings.

L. DOCUMENTATION

In commercial aviation, documentation requirements vary from airline to airline. None, however, require the extensive documentation indispensible to military procurement. There are a number of reasons for requiring the contractor to provide documentation. Some is required by operators and maintenance men, some by statute, and some by specialists in functional disciplines (e.g., configuration control). A great part of it, however, is generated to satisfy the formats of various management information systems (MIS) or in response to someone trying to "cover his number." All of the manufacturers responding to the author's inquiries cited documentation as a major area effecting cost increases to the military.

M. RELIABILITY

It is difficult to analyze the effect that differences in specifications have on equipment reliability. Certainly the higher standards are contained in MILSPECs. ARINC Characteristics allude to reliability, but

set no definitive standards at all. As noted in Phillip Klass' study, however, equipment built to ARINC Characteristics consistently achieved higher reliability than similar military equipment.[21] While some of this reliability can be attributed to maintenance experience and procedures, a portion must be ascribed to the specifications themselves and to procurement procedures.[22] The competitiveness of the airline market seems to be at the root of the higher reliability. With competition ended at the time of contract award, the military contractor has little incentive to do more than just meet the specifications.

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[21] P. J. Klass, "New Data Yields...."

[22] Ibid. Klass noted that airline type equipment used by the Air Force gave better reliability than similar equipment developed under government contract to meet a MILSPEC and procured on a low-bid basis.

VI. PROCUREMENT

The procedures used in procuring equipment directly affect the cost. Here again, relatively cumbersome procurement procedures contribute to the increased costs borne by the government.

A. CIVILIAN PROCUREMENT

The airlines, taken as a whole, approach procurement with an entirely different point of view than does the military. While both groups seek to enhance competition, the airlines learned, several years ago, that buying as a group from a single source did not accomplish this. Civilian organizations, in general, are not restrained in their procurement procedures by public laws and, therefore, each organization's practices will vary according to company policy and the incumbent purchasing agent. Because of the uniqueness of the situation in the industry however, some generalities apply to all airlines in the area of avionics acquisition.

1. "Fly before Buy" Concept

Issuance of an ARINC Characteristic does not insure that all airlines, or, indeed, any airline, will order equipment built to that specification. As noted in the specification foreword, it is merely the "considered opinion of airline technical people" about what is required. Based on his own interpretation of that opinion, each manufacturer is free to design and develop his equipment incorporating all of the

functional requirements, but adding whatever features or technology he feels will make his product more competitive. When his and his competitors' equipments come on the market, the airlines employ a concept similar to that reintroduced to the military procurement scene by former Under Secretary of Defense, David Packard -- "Fly before buy." The airlines separately evaluate the equipment, each according to its own standards and needs. The results of this evaluation lead to the selection of a particular manufacturer's equipment.

2. Separate Orders

No manufacturer has a corner on the airline market. Based on its own evaluation and the equipment prices, an individual airline may purchase its equipment from any one or combination of manufacturers. A manufacturer who's share of the market is declining is forced to improve his product or lower his price in order to remain competitive.

3. Use of Warranties

Virtually all airline avionics equipment is purchased under warranty. Over a number of years, many of the provisions of the warranty agreement have become standardized, although the wording and degree of application may vary somewhat between transactions. In substance however, the warranty tells the buyer that the equipment he has purchased will work as stated. If it does not do so, the manufacturer is liable for at least some of the costs of correcting the fault.

B. MILITARY PROCUREMENT

Complicated by the more than 68,000 policy and procedure documents concerning acquisition and the political considerations underlying them, military procurement can be the subject of several life-long studies. The treatment given here, then, is, at best, fleeting. A general overview, however, indicates the part played by the specification in the procurement process and, by comparison with airline procedures, points out some other areas where further intense study is needed.

1. Political Considerations

In an effort to legislate honesty and fairness, the Congress has passed many statutes affecting procurement. The primary statute affecting DOD is the Armed Services Procurement Act of 1947. However, laws covering such subjects as equal employment opportunity (EEO) prohibit discriminatory hiring practices among government contractors. Other laws set aside a certain percentage of government business for minority firms or small businesses. Still others regulate, to a degree, the manner in which a contractor operates and manages his business. The Commission on Government Procurement report estimated that some 4000 laws impact on the procurement process. Unquestionably, most of these laws have much social merit. The machinery to implement and enforce them costs money however, and this cost is added to the contract price. As society becomes more enlightened, hopefully, the idea of equal opportunity and other social concepts will become more universally accepted and the sometimes ponderous machinery to enforce them can be dismantled.

2. Procurement Philosophy

The Armed Services Procurement Regulations (ASPR) is one of the many documents which are designed to implement the public laws. Recognizing that the government is the largest consumer of goods and services in many fields, these regulations strive to insure that a fair attitude is maintained in all procurement transactions. To do less could mean the failure of a number of private concerns which rely on government business to remain solvent. In this effort, ASPR requires, in most cases, that a contract be awarded to the lowest responsive and responsible bidder. To be responsive, the bidder must indicate a willingness to perform on the government's terms. A responsible bidder is one with the capacity and ability to perform the contract. Very little, if any, consideration can be given to the bidder's past performance. A contractor who has consistently defaulted on previous contracts is rarely excluded from competition if he can demonstrate that he has the capacity and ability to perform the contract. This provision has also invited abuses. Contractors have been known to "buy in" (i.e., bid unrealistically low in order to win the contract), knowing that the government will bail them out when they have cost overruns.

Little encouragement is made for use of warranties in procurement regulations. ASPR states that warranties shall be used when in the "best interests of the government," but provides a lengthy list of factors to be considered before deciding to include a warranty. Most of these measure costs versus risk. Not many contracting officers are

endowed with Solomon-like wisdom with which to weigh the risk. All are completely aware of how the added initial costs will be weighed by superiors and investigatory bodies. Future maintenance costs, being difficult to estimate, are usually ignored. The result is that very limited use of express warranties is made in military procurement. Since no regulation forbids it and no cost is involved, implied warranties (i.e., warranty against latent defects or fraud) are normally afforded the government just as they are to any private consumer.

The desire for incorporating the latest state of the art into military equipment has engendered a propensity for making changes to military procurement contracts. This is particularly so for those items which require long development or construction periods, such as fighter aircraft or nuclear carriers. These changes are among the major causes of cost overruns.

While a few of the bad effects of government procurement procedures have been cited, some unique features of procurement regulations work to the benefit of the government and result in savings. As can any party to a breached contract, the government can terminate a contract for default and seek remedies. Beyond this however, the government can terminate a contract for anticipatory breach of contract when it demonstrates that contractor progress is such that the contract cannot be fulfilled. One more government recourse not available to a private party to a contract is termination for convenience. Any develo-ment which eliminates the need for an existing contract can be cause

for this type of termination. While some costs are involved in terminating for convenience, the overall effect is to save government funds.

VII. THE FUTURE

One beneficial effect of the austere budget is that senior military people are becoming more aware of the problems. While, in the past, the attitude often existed that a "shotgun" approach with more money would solve any problems, a realistic assessment is now being made of many military programs before money is poured into them. Prior to 1971, for example, communications capabilities were developed in reaction to uncoordinated command and control requirements. The result was a fragmented communications system. In 1971, the CNO, Admiral Zumwalt, reorganized his staff, drawing all command support activities into one office. Since that time, all command support programs are coordinated and directed from one central office. Vice Admiral Fritz J. Harlfinger, the director of this office, has solicited industry help in developing needs and assessing technical feasibility in the Navy's command, control, and communications.[23] Rear Admiral Warren M. Cone, Deputy Director of the Communications-Electronics Directorate in the office of the Joint Chiefs of Staff (JCS), has noted other promising trends. He foresees more emphasis being placed on commercial development of communications and electronics equipment within general functional

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[23]VADM F. J. Harlfinger, II, USN, "Command, Control and Communications in the Navy Now and in the Future," Signal, v. 28, pp. 6-7, February 1974.

specifications rather than detailed design specifications. He also sees a concerted move toward more universal application of equipments and removal of institutional barriers separating strategic and tactical communications.[24]

To achieve these goals, several organizations have been formed recently. TRI-TAC, an agency of the office of the Secretary of Defense, is charged with developing common solutions to the shared tactical communications requirements of all the military departments. The Joint Standardization Group, within the JCS, is also seeking to avoid duplication of communications requirements and to increase interoperability through standardized equipment and procedures. Within the Navy, the Naval Telecommunications Architecture Group (NTSAG) has been taking the first comprehensive look at where naval telecommunications are now and is charting a course for the future direction. Their report, due in July 1974, will provide the Navy with its first overall plan for telecommunications for the next ten years.

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[24]RADM W. M. Cone, USN, in address to NPGS Communications Management students, 21 February 1974.

VIII. CONCLUSIONS

This study has concerned itself with aircraft communications equipment, largely because this area is one in which reasonably close parallels can be drawn between civilian and military requirements. The conclusions drawn, then, are based on this rather specific area. Since military procurement procedures for communications equipment differ little between aircraft, ships, or tanks, the conclusions, for the most part, can apply equally to all military communications equipment procurement.

A. PRICE DIFFERENTIAL

Since each procurement transaction is the subject of separate contract negotiations in both the airlines and military, no specific price figures have been cited. All of the manufacturers contacted agreed that the military pays more. Percentages of price increase were estimated to range from 10-15% to 1000% that of an equivalent, high-quality, commercial set. While a definite amount or percentage is impossible to state, the conclusion can be drawn that the military does pay more for equipment of similar capabilities.

B. ENVIRONMENT

With some exceptions, aircraft of both the military and the airlines operate in essentially the same environment and, therefore, have

the same environmental requirements. The more stringent requirements imposed by the military accounts for part of the increased cost.

C. SPECIFICATIONS

The manner in which MILSPECs are written, with heavy reliance on detailed design characteristics and specific components, leads to sole-source procurement and higher costs. Further, the process of developing the requirement and specification, excluding the user and manufacturer, can result in a product which either does not meet the user's needs or which contains unnecessary and expensive frills.

D. PRODUCT RELIABILITY

The reliability of a product is the function of many variables. In the relatively noncompetitive atmosphere of military procurement, all of these variables must be considered in specifying the degree of reliability desired. This is rarely done. The bidder, knowing that competition will end with the contract award, seeks to minimize his costs. Building greater reliability than specified into an equipment almost assures him of losing the contract. When building equipment for a competitive market however, he is aware that reliability is one of his strong selling points. No minimum standards need be specified to encourage him to design a reliable piece of equipment. For these and other reasons, the airline industry, in general, acquires more reliable equipment.

E. STATE OF THE ART

While there is ample evidence to support an argument in either direction, the author has concluded that, for normal communications requirements, civilian type specifications and procurement procedures advance the state of the art more so than do the military.[25] Certainly there are many areas in which the military have led in development. Much of the early work in satellite communications was done for the military, for example. Most of the more recent developments in this area, however, have received their impetus from commercial application. Again, except for R and D, cost reimbursement type contracts, most contractors are unwilling to risk capital with little chance of return.

F. TESTS

The myriad of tests required in military specifications are necessary only because of the noncompetitive procurement situation. The airlines' practices of shopping around for equipment and buying under warranty eliminates much of the need for extensive tests. While the warranties themselves add to the initial costs, they insure continued manufacturer involvement resulting in improved reliability and less expensive testing requirements.

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[25] W. D. Gahres takes the opposite point of view in his study, A Comparative Analysis of P-3C Avionic Specifications. . .

G. DOCUMENTATION

The extensive documentation required by statutes, contracts, and/or specifications is a major factor in raising the costs of equipment to the military. For documentation required to satisfy management information needs, much of this information is duplicative of records kept by the contractor in the course of managing his business. The added costs are incurred by requiring him to format his reports to suit various MIS systems.

H. PROCUREMENT

Government procurement procedures have become complicated to the point that no one person is totally conversant with all aspects of the procedures. Far from minimizing costs while maximizing competition, these procedures tend to have the opposite effect.

IX. RECOMMENDATIONS

A. STANDARDIZATION

A high level review of all communications requirements should be conducted on a continuing basis within the Navy in order to achieve a greater degree of standardization. The obvious advantages are interchangeability and lower costs through quantity buys.

B. USER AND MANUFACTURER INVOLVEMENT

Users, drawn from all types of platforms expected to carry the equipment, should be involved in firming up the requirements and writing the specifications. By bringing current operational experience to bear, unnecessary frills will be omitted and, at the same time, important details will not be neglected. Manufacturers should also be invited to participate in this development process. The realistic assessment of cost which they can provide will eliminate many expensive extras. They will also gain a better understanding of the needs. As an initial step, manufacturers should be invited to observe equipment working in an operational environment and have the functional requirements explained to them by the users. While this is done to a slight degree with members of the National Security Industrial Association, these members are normally senior executives in their corporations and the basic education which they receive does not reach down to the equipment designers.

C. AEEC

The Navy should seek representation on the AEEC. Staying up to date on the airline state of the art could eliminate covering much of the same ground in the Navy. It would probably become apparent as well, that ARINC equipment, with little or no modification, would suit many Navy needs.

D. FUNCTIONAL SPECIFICATIONS

The Navy should make better use of functional specifications to describe its needs. Liberal use of notes in these specifications will ensure that manufacturers understand these needs. By thus encouraging innovative thinking on the part of the contractor, a better product will result.

E. PROCUREMENT

With no changes to the present procurement regulations, several steps can be taken to improve competition and lower the cost of equipment. One approach would be to award small developmental contracts to three or four manufacturers,having each develop and produce a prototype for further evaluation. As in the "fly before buy" concept, the models resulting from these contracts can be evaluated against each other, taking into consideration minimum needs, reliability, ease of maintenance, and life-time cost. With all of these factors considered, a reasonable choice can be made.

F. TESTS AND WARRANTIES

The heavy test requirements imposed on the contractor should be studied with a view toward combining or eliminating certain tests. Such tests as are required should be aimed at checking the considerations in the previous paragraph. These tests should, in the main, be conducted by the Navy. Greater use of warranties in buying will eliminate the need for many tests. The contractor will continue to conduct such tests as he feels necessary to minimize his risks under the warranty. While the warranty will increase the price of the equipment, an overall savings should result from elimination of many tests and the documentation that goes with them. More reliable equipment will also result.

G. PROCUREMENT REGULATIONS

The lengthy study recently completed by the Commission on Government Procurement covered all aspects of government procurement and contained many excellent recommendations which, if implemented, could streamline the acquisition process. These recommendations should be pursued and applied as soon as possible. One area deserving of particular attention is documentation. This is an area which is costly to the government and which should be relatively easy to improve. Perhaps something as simple as standardizing the documentation requirements of all government agencies would ease this problem.

H. FURTHER STUDY

Finally, this study has touched briefly on several areas concerning specifications for aircraft communications equipment. Further in depth study of any one of these areas will undoubtedly, yield many more constructive recommendations. The author gained the distinct impression throughout his research that many of the problems uncovered have been viewed as technical problems to be solved by engineers. Quite the contrary, most of the problems noted are managerial problems which call not for a technical approach, but for a common sense solution.

Table 1. ADVANTAGES AND DISADVANTAGES OF THE TWO TYPES OF SPECIFICATIONS

Specification Features	ARINC Characteristics		Military Specifications	
	Advantage	Disadvantage	Advantage	Disadvantage
Cost	Lower because of competition and manufacturer participation			Higher because of single source procurement and detailed design requirements
Reliability	Generally higher because of competition and use of warranties			Generally lower because equipment only meets minimum standards
Form Fit and Interface	Standard for each equipment type			Unique for each application
Meeting minimum needs	Generally greater because of user participation			Probably meets more than mimimum needs as user not normally consulted
State of the art advances	For normal needs probably higher due to competition		Pushes state of the art for exotic applications	For normal needs may be missed
Clarity	Greater due to use of narrative style			May be misunderstood due to absence of explanatory notes
Innovation	Functional specification encourages manufacturer innovation			Design specification tells mfr exactly what to build

BIBLIOGRAPHY

1. ARINC Research Corporation Report, A Comparative Analysis of P-3C Avionic Specifications and Similar Commercial Avionic Specifications, by W. D. Gahres, March 1973.

2. ARINC Research Corporation Report 0637-02-1-1243, The Use of Warranties for Defense Avionics Procurement, by H. Balaban and B. Retterer, June 1973.

3. Department of Defense, Armed Services Procurement Regulations, 16 April 1973.

4. Department of Defense Military Specification MIL-E-5400P, Electronic Equipment, Airborne, General Specification for, 2 July 1973.

5. Department of Defense Military Standard MIL-STD-188C, Military Communications System Technical Standards, 24 November 1969.

6. Klass, P. J., "New Data Yields Clues to Reliability," Aviation Week and Space Technology, v. 86, p. 80-87, 13 February 1967.

7. U. S. Commission of Government Procurement, Report of the Commission on Government Procurement; pursuant to Public Law No. 129, 91st Congress, as amended, Washington, Government Printing Office, 31 December 1972.

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The military often pays more for communication equipment of similar capabilities to that purchased by civilians. Despite this, equipment reliability has proven to be much lower. This study undertook to analyze and compare the salient features of two types of specifications used to express communications equipment requirements by the Navy and commercial airlines. The manner in which requirements are developed and specifications drawn were

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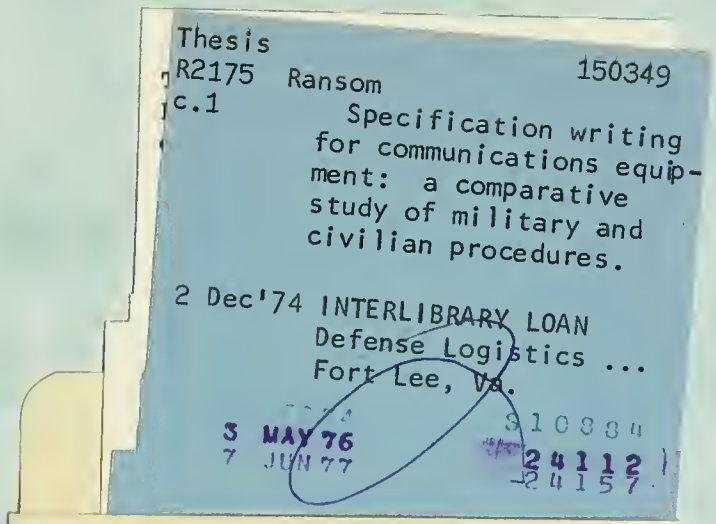
examined. Procurement procedures, another factor contributing to the price differential, were also examined briefly. Airline specifications, called ARINC Characteristics, and airline procurement methods were shown to encourage competition to a greater degree with a lower price and greater reliability resulting.



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